



BANGALORE ELECTRICITY SUPPLY COMPANY LIMITED



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Section – 6(D)

**Inspections, Tests, Training and Documentation for RMUs,
SPBs and LRC & LBS**

**“Expansion of Distribution Automation System to Peri-Urban
areas of Bangalore city, District Headquarters & Industrial
areas across BESCOM Jurisdiction”.**

Issued By

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1. Project Implementation

This clause specifies project implementation requirements including the Employer and Contractor responsibilities, design documents, Testing procedures, installation, commissioning, Integration with DAS system and Training activities.

1.1 Implementation Responsibilities

The general responsibilities of the Employer and the Contractor are presented below. Other clauses in the Technical Specifications also present or allude to specific responsibilities. If the requirements of any other clauses conflict with the responsibilities of this clause, the responsibilities of the other clauses shall take precedence.

1.2 Contractor Responsibilities

The Contractor shall design, supply, install, commission and integrate the specified quantity of RMUs, SPBs and Sectionalizers(LRC & LBS) in a given lot so that they are in good clean working order, fit for their intended purpose, and fully integrated with the corresponding DAS master station. In this respect, the Contractor's responsibilities shall include, but shall not be limited to:

- 1) Ensuring the RMUs, SPBs and sectionalizers(LRC & LBS) are designed and engineered to meet the Employer's requirements fully and completely in coordination with the DAS master station.
- 2) Provision of RMUs, SPBs and sectionalizers(LRC & LBS) installation plan aimed at minimizing installation and testing times while ensuring minimum power disruption for Employer customers.
- 3) Supplying all necessary materials and performing all necessary fabrication, testing, wiring, and interconnection work during the process of assembling or otherwise producing the RMUs, SPBs and sectionalizers(LRC & LBS) with the RTUs
- 4) Participation in project meetings, such as design and progress review meetings, and submission of all necessary transmittals related, for example, to items such as meeting agendas, meeting minutes, progress reports, etc.
- 5) Ensuring and periodically demonstrating that the work is progressing according to the approved schedule.
- 6) Completing all relevant type testing, prototype testing stage wise and factory testing prior to the delivery of each RMUs, SPBs and sectionalizers(LRC & LBS) with the RTUs to its assigned feeder site. Testing shall include use of all necessary Contractor-supplied test equipment in addition to using the DAC Simulators to be provided by the Employer (via the DAS supplier) where applicable.
- 7) The Contractor shall host Employer Project Management visits at the manufacturing facilities to facilitate high-level coordination, oversight of the manufacturing process, and

witnessing of production and quality control procedures for RMUs, SPBs, Sectionalizers(LRC & LBS). This includes covering all travel and accommodation expenses for **2 batches** (3 personnel each) for **LRC & LBS**, and **4 batches** (3 personnel each) for **SPB & RMU**. All logistics, itineraries, and venues must be finalized and approved by the Employer in advance to ensure full alignment with project requirements.

- 8) Provision of all necessary test equipment.
- 9) Transportation of the RMUs, SPBs and sectionalizers(LRC & LBS) and all accessories to their assigned sites.
- 10) Installation of the sectionalizers(LRC & LBS) and all relevant accessories on the available pole structures. This shall include sectionalizer(LRC & LBS) connections to the distribution network, the installation of surge arresters, proper grounding independently of the associated pole structures, and LRC protection coordination with respect to associated substation circuit breakers. Sectionalizers shall only be mounted on pole structures that are fit for purpose. Consequently, before starting such installations, the Contractor shall survey each site to ensure that this requirement is met.
- 11) Assistance during system end-to-end testing by the DAS supplier/Employer. In this respect, Contractor personnel shall be readily available to identify and resolve related RMUs, SPBs and sectionalizers problems (if any). This shall include any necessary modifications or adjustments to the installed RMUs, SPBs and sectionalizers.
- 12) Provision of preliminary and as-built drawings, functional design documents, operation and maintenance manuals, test plans, test procedures, and test reports.
- 13) Maintaining the RMUs, SPBs and sectionalizers equipment until acceptance and start of the corresponding warranty period. Annual Maintenance contract will commence after completion of warranty period.
- 14) The Contractor has to abide by the prevailing standard safety policy.

1.3 Employer Responsibilities

Employer responsibilities will include supervision and support of all Contractor activities as follows:

- 1) Review and approval of Contractor-supplied drawings, manuals, design documents, training materials, test procedures, and other required documentation within 30 days from the date of submission.
- 2) Ensuring communications links between equipment and DAS master station
- 3) Participation in Contractor-provided training courses. This will include Employer evaluation of these courses to ensure the training objectives are met.

- 4) Witnessing RMUs, SPBs and sectionalizers(LRC & LBS) production and quality control procedures as well as subsequent Prototype, factory and End-End tests.
- 5) Review and approval of Contractor-supplied work plans for installing the RMUs, SPBs and sectionalizers(LRC & LBS).
- 6) Inspection and approval of goods and materials both before and at time of delivery.
- 7) Coordination and supervision of the Contractor's on-site work.
- 8) Arranging Line Clear for installation and commissioning of RMUs, SPBs & sectionalizers(LRC & LBS) with RTUs.
- 9) Inspection and approval of completed RMUs, SPBs and Sectionalizers(LRC & LBS) installations.

2. Scope of Works

- a. Design, manufacture, supply, installation, commissioning and integration of the RMUs, SPBs and Sectionalizers(LRC & LBS) with DAS system as per the contract scope.
- b. Conducting tests on the RMUs, SPBs and Sectionalizers(LRC & LBS) at manufacturer end as per IS, IEC & DAS specification.
- c. Packing, preservation, transportation from the manufacturer's work place to the consignee stores. Delivery including loading & unloading of materials at Consignee Stores.
- d. Transportation of RMUs, SPBs and Sectionalizers(LRC & LBS) to Employer specified site.

3. Project Organisation

The primary points of contact between the Employer and the Contractor shall be their respective project managers.

3.1 Employer's Project Manager

The Employer's Project Manager shall be responsible for representing the Employer's interests throughout the project. The Employer's Project Manager will, from time to time, authorise other staff to act in this regard for specific tasks. The Project Manager will also change such assignments from time to time. Such actions shall be submitted to the Contractor in writing.

All correspondence with the Employer shall be addressed to the Employer's Project Manager.

3.1.1 Contractor's Project Manager and Project Personnel

The Contractor shall designate a project manager who shall be responsible for the co-ordination of all project work and for the communications between the Contractor and the Employer. The Contractor's Project Manager shall be subject to approval of the Employer. Except for conditions outside the control of the Contractor, the Contractor's Project Manager shall not be removed or replaced without the approval of the Employer.



The project shall be staffed with a core project team. Additional personnel shall be assigned to work under the direction of the core team as required to effectively implement the System. Core project team members shall have previous experience in a similar position on at least one (1) other project that is similar in size and scope to this project.

The Contractor shall inform the Employer of any pending or possible changes in the use or status of all Contractor project personnel. Any changes to Contractor staff, including work assignments and participation level, shall be announced as soon as practical and shall be subject to the Employer's approval. The Employer shall have the right to have any Contractor staff removed from the project for cause and without justification.

4. Project Schedule

The project schedule shall consist of an implementation schedule, a documentation schedule, and a training schedule. The project schedule shall be provided within 15 days after contract award and, as a minimum, shall ensure the following specific milestone requirements are met:

4.1 Project Documents

Project documents shall include the following documents but not limiting to:

1. Project Schedule and Detailed Implementation schedule
2. Design documents and as-built drawings
3. Equipment manuals
4. Project Progress Report
5. Project meetings proceedings
6. Test procedures and documents
7. Training documents

5. Inspection and Test

Inspections and tests shall be performed to ensure all RMUs, SPBs and Sectionalizers components comply with these Technical Specifications. Responsibility for conducting the inspections and tests shall rest with the Contractor. The Employer will participate in the inspections and will witness the testing as described in the following sub-clauses.

5.1 Inspections

Employer representatives shall be allowed access to any Contractor or other facility where the RMUs, SPBs and Sectionalizers or their component parts are being produced or tested. Such access will be used to verify by inspection that the RMUs, SPBs and Sectionalizers are being or have been fabricated and tested in accordance with the Technical Specifications.

The Contractor shall give the Employer 15 days notice in writing concerning the date and place at which the equipment will be ready for inspection or testing. The Contractor shall provide all the necessary assistance and facilities to Employer representatives to carry out such inspections and test witnessing.

The Employer representatives will also visit Employer sites where the RMUs, SPBs and Sectionalizers have been delivered and are being or have been installed and tested to ensure the installations and testing are proceeding or have been completed in the manner intended.

The Contractor shall provide any and all documentation that is necessary to complete the inspections. The Employer shall be allowed to inspect the Contractor's quality assurance standards, procedures, and records. Inspections, as a minimum, shall include checks on inventory, general appearance, cabling, drawing conformance, and labeling.

Where applicable, the Employer's inspections will be performed in conjunction with witnessing the RMUs, SPBs and Sectionalizer tests. The Contractor shall take all necessary steps to address and resolve any concerns that Employer representatives may raise as a result of these activities in a timely fashion.

This may result in further inspections and tests until the representatives are fully satisfied that the inspections and tests have been completed successfully.

5.2 Test Procedures

The Contractor shall provide test plans and detailed procedures for all required testing. The plans and procedures shall ensure that each test is comprehensive and verifies proper performance of the RMUs, SPBs and Sectionalizer under test and, in this respect, shall be submitted for review and approval by the Employer.

The test plans shall include all routine tests and acceptance tests as per relevant IS/IEC standards and shall describe the overall test process including the responsibilities of the test personnel and how the test results will be documented.

The test procedures shall describe the individual tests segments and the steps comprising each segment, particularly the methods and processes to be followed.

5.3 Test Reports

The Contractor shall maintain complete records of all test results. The records shall be keyed to the test procedures.

Upon completion of each test, the Contractor shall submit a test report summarizing the tests performed and the results of the tests. The test report shall include the following information:

- Test Log - A chronological record of all events related to execution of the tests.

- Test Incident Report – A detailed description of any event during the testing process that required investigation.
- Test Summary Report – A presentation of results pertaining to the designated test activities and a summary of all relevant recommendations and conclusions based on these results.
- Variance Report – A summary of the problems detected during testing and the corresponding resolutions.
- Official Certification – A formal declaration that the required testing was performed and, if applicable, was completed successfully.
- Signatures – As designated representatives of the Contractor and/or Employer, the signatures of witnesses for each completed test, whether successful or not successful, along with relevant dates. Witness names and contact information shall also be provided.

5.4 Type Tests

Bidders shall submit type test certificates for all equipment/materials conducted in an accredited third-party test laboratory. Failure to conform to this requirement may constitute grounds for rejection of the bidder's proposal. If the test certificates are older than 10 years, the tests shall be carried out again by the Contractor prior to full-scale manufacture of the deliverable RMUs, SPBs and sectionalizers and shall be performed at an accredited third-party test laboratory selected by the Contractor and approved by the Employer.

5.5 Proto type Test

5.5.1 Stage-by-Stage Inspection Proto-type Inspection of RMU & SPB.

The Employer reserves the right to witness and approve the following manufacturing stages. The Contractor shall not proceed to the next stage without written clearance from the Employer:

Stage 1: Design Approval

- Design & Documentation Review: Evaluate GA drawings, single-line diagrams, 2D & 3D CAD drawings, bill of materials, panel wiring schematics prior to procurement, type test reports, quality assurance plan and compliance matrix against technical specification requirements of RMUs and SPBs.

Employer issues design approval letter and clearance of critical component list before fabrication commences.

Stage 2: Material Verification, Fabrication & Primary Assembly Inspection

- Incoming Material Inspection: Verify SF6 tanks, vacuum interrupters, Bus bars, conductors, insulators, current transformers, potential transformers, auxiliary transformers, fault passage indicators, numerical relays, multifunction meters, auxiliary transformers, motors, cables, enclosures, etc, as furnished by the Contractor during design stage against approved vendor lists and standards.
- Enclosure Fabrication: Inspect panel fabrication, welding quality, corrosion protection (coating thickness), hot-dip galvanizing, IP rating verification, base frame compatibility with 3-way/4-way/5-way RMU & SPB installations

- Primary Tank & Busbar Assembly: Verify SF6 tank leak tests, internal arc proofing evidence, assembly of load break switches, circuit breakers (vacuum interrupter type), earthing switches, cable bushings, busbar joints and clearances.
- Mechanical Interlocks & Safety Features: Validate all fail-safe interlocks between CB/LBS/earthing switches, door interlocks, padlocking, anti-reflex handle mechanisms, live-line voltage indicators, SF6 overpressure venting direction, maximum manual operating force.

Employer witnesses open SF6 tank inspection, bus bar assembly verification and complete interlock functional demonstration before tank closing and final painting completion.

Stage 3: RMU/SPB Integration with RTU Interface Verification

- Control Wiring & Sensors: Inspect CT/PT mounting, wiring routing segregation, terminal block arrangements with CT shorting links, RMU/SPB-RTU multi-pin, ferruling and colour coding.
- Power Supply & Battery System: Verify auxiliary transformer rating, battery capacity backup including RTU, radio/modem, motors, relays and multifunction meters, battery type and capacity, charger settings, alarm implementations (DC low voltage, AC fail, battery failure, grounded battery etc), deep discharge protection, theft-proof battery compartment with audible alarm.
- RMU/SPB RTU Interface & I/O Mapping: Conduct bench testing of MODBUS communication between numerical relays, multifunction meters and RTU via RS485 ports. Test continuity and logic of all digital inputs and control outputs, switch logic and control inhibit conditions as furnished by the employer during design stage.

Employer witnesses control wiring completion inspection, power supply system energization with alarm simulation, and RTU bench test with simulated digital inputs/outputs and MODBUS communication

Stage 4: Prototype Functional Testing & Demonstration

- Pre-Routine Electrical Tests: Execute all routine factory tests on the assembled proto RMU: insulation resistance measurement using megger, high-potential tests where applicable, primary and secondary injection testing of protection relays, FPI functional verification with simulated fault currents, CB/LBS mechanical operations (manual and motorized), spring charging sequence verification, auxiliary circuit continuity, space heater operation, control cabinet lighting and power receptacles, SF6 gas pressure verification etc, as furnished by the Contractor during design stage.
- Integrated Functional Demonstration: Conduct complete end-to-end operational demonstration under simulated DAS field conditions without grid energization. Execute remote control operations from simulated DAS/RTU HMI: LBS/CB open/close commands with acknowledgment, verification of all status indications at RTU (device positions, earthing switches, springs charged, local/remote mode), alarm generation and transmission (SF6 low, door open, battery alarms, FPI trips, relay trips), analog measurement display from multifunction meters (voltage, current, power, energy, power factor for main line circuits), verification of mimic diagrams on front plates, confirmation of nameplate information and danger boards etc, as furnished by the Contractor during design stage.

5.5.2 Stage-by-Stage Prototype Inspection of LRC & LBS

Prototype Inspection of Line Reclosers (LRC) and Load Break Switches (LBS), the Contractor shall submit a detailed Stage-by-Stage Quality Assurance Plan (QAP) for Employer approval. The Employer reserves the right to witness and approve the following manufacturing stages. The Contractor shall not proceed to the next stage without written clearance from the Employer:

- **Stage 1: Design Approval**

- Design, Documentation, Evaluate GA drawings, single-line diagrams, Review of 2D & 3D CAD Drawing, detailed Bill of Materials (BOM), panel wiring schematics prior to procurement, type test reports, quality assurance plan and compliance matrix against technical specification requirements
- Employer issues design approval letter and clearance of critical component list before fabrication commences.

- **Stage 2: Material Verification, Fabrication & Primary Assembly Inspection**

- This stage includes the physical inspection of critical raw materials and components, such as vacuum interrupters, solid dielectric materials, auxiliary transformers, FRTU and its associated components and current/voltage sensors etc., and other materials as furnished by the Contractor during design stage against approved vendor lists and standards.
- Inspection of the control cabinet fabrication, welding quality, corrosion protection (coating thickness), hot-dip galvanizing, meets IP overall protection and IP for electronic modules as per Technical specification and features the required finish coat. This stage also covers the mechanical dry-run of the switch mechanism, verifying manual hook-stick operations and the mechanical latching systems.
- **Stage 3: Sectionalizer (LRC & LBS) Integration with RTU Interface Verification**
- RTU, SPS, and Control Panel Integration Verification of the "brains" of the unit. This includes inspecting the internal wiring, battery capacity backup including RTU, radio/modem, terminal blocks, the Switch Power Supply (SPS) and battery charger, charger settings, alarm implementations (DC low voltage, AC fail, battery failure, grounded battery etc), deep discharge protection, theft-proof battery compartment with audible alarm and the RTU modules. This ensures the unit is physically SCADA-ready and wired neatly to prevent EMI/RF interference.
- Sectionalizer(LRC & LBS) RTU Interface & I/O Mapping: Conduct bench testing of MODBUS communication with RTU via RS485 ports. Test continuity and logic of all digital inputs and control outputs, switch logic and control inhibit conditions as furnished by the employer during design stage.

Employer witnesses control wiring completion inspection, power supply system energization with alarm simulation, and RTU bench test with simulated digital inputs/outputs and MODBUS communication.

- **Stage 4: Prototype Functional Testing & Demonstration**

- Execute all routine factory tests on the assembled proto Sectionalizer(LRC & LBS): insulation resistance measurement using megger, high-potential tests where applicable, primary and secondary injection testing of protection relays this includes testing protection

relays (O/C, E/F, SEF), FPI functional verification with simulated fault currents, Sectionalizer (LRC & LBS) mechanical operations (manual and actuators), auxiliary circuit continuity, control cabinet lighting and power receptacles etc, as furnished by the Contractor during design stage.

- Integrated Functional Demonstration: Conduct complete end-to-end operational demonstration under simulated DAS field conditions without grid energization. Execute remote control operations from simulated DAS & RTU HMI: Sectionalizer (LRC & LBS) open/close commands with acknowledgment, verification of all status indications at RTU (device positions, local/remote mode), alarm generation and transmission (door open, battery alarms, FPI, relay trips), analog measurement display(voltage, current, power, energy, power factor for main line circuits), confirmation of nameplate information and danger boards etc, as furnished by the Contractor during design stage.
- Proto type inspection Functional & Routine Testing Witnessing the manufacturer's internal dry-run of all operational functions in Proto type inspection. Verifying the DNP3/TCP-IP communication ports, and confirming interoperability with the DAC Simulator.

One RMU, SPB and Sectionalizers(LRC & LBS) to be supplied shall be offered for Proto type testing by the Manufacturer, which shall ensure that the RMUs, SPBs and Sectionalizers(LRC & LBS) have been designed to meet the Employer's functional requirements in all respects. Employer representatives shall witness the test on a representative RMU, and the test shall be carried out in accordance with the Contractor's test plan and procedures as approved by the Employer. Should the Prototype test prove unsatisfactory in any way, the Employer reserves the right to have further tests conducted, Contractor shall be responsible for the additional cost and, if applicable, request further improvements in the Contractor's RMU, SPB and Sectionalizers(LRC & LBS) design. Only after approval the manufacturer shall commence Bulk manufacturing. The Contractor shall be responsible for all logistics and expenses, including air travel and accommodation, for Employer representatives to attend the three-stage (i.e stage2 to stage4) prototype inspection for each RMU, SPB & Sectionalizers(LRC & LBS) make. These inspections shall be conducted in batches of 2 to 3 members per batch per make of the Equipment to ensure the equipment meets all design and quality standards.

Employer signs formal acceptance that the proto RMU, SPB and Sectionalizer(LRC & LBS) has successfully completed all pre-prototype inspections and functional demonstrations and is ready to be offered for Prototype Test.

5.6 Factory Acceptance Test

A factory acceptance test shall be conducted to ensure that the RMUs, SPBs and Sectionalizers have been designed to meet the Employer's functional requirements in all respects. The Employer representatives shall witness the test on representative RMUs, SPBs and Sectionalizers, and the test shall be carried out in accordance with the Contractor's test plan and procedures as approved by the Employer. All required travel by air and accommodation of Employer representatives (2 to 3 members) shall be borne by Contractor.

- RMUs & SPBs: 8 batches of 2 to 3 personnel.
- LRC & LBS: 4 batches of 3 personnel.

Should the factory acceptance test prove unsatisfactory in any way, the Employer reserves the right to have further tests conducted and, if applicable, request further improvements in the Contractor's RMUs, SPBs and Sectionalizers designs. The test shall demonstrate the capability of the RMUs, SPBs and Sectionalizers to interoperate with the DAS.

To the extent possible, the test shall demonstrate the capability of the RMUs, SPBs and Sectionalizers to interoperate with the RTU to be supplied by the contractor. It is also the intent of the Employer that the test shall make use of the Data Acquisition (DAC) Simulator (representing the DAS) to be provided by the Employer which will reduce the risk of discovering interoperability problems subsequent to RMUs, SPBs and sectionalizers installation at site. Thus, in preparation for the factory acceptance test, the Contractor shall make every effort to cooperate and coordinate all such activities with these other contractors.

5.7 Routine Factory Tests

These tests shall be carried out during RMUs, SPBs and Sectionalizers manufacture as a quality control measure, i.e., to ensure each RMUs, SPBs and Sectionalizers to be delivered meets the Employer's minimum requirements including all relevant standards. Recording and reporting the routine test results shall be the responsibility of the Contractor.

At the Employer's discretion, Employer representatives will witness such testing. This may include requesting the Contractor to perform tests on RMUs, SPBs and Sectionalizers selected at random from each batch of RMUs, SPBs and sectionalizers that the Contractor deems ready to be delivered to site. Should any such test prove unsatisfactory, the Employer reserves the right to have further tests conducted and for delivery not to take place until a mutually agreed course of action has been reached.

5.8 Field Performance Tests

5.8.1 Unit Test

If installed before warranty period this shall include unit testing by the Supplier at the time of installation of each RMUs, SPBs and Sectionalizers to ensure all components can be powered up and are in good working order.

During testing, it shall be demonstrated that the breaker and FRTU can interoperate successfully in all respects from the BESCOM DAS Control centre. Thus testing shall verify that the RMUs, SPBs and Sectionalizers interface is fully operational and capable of meeting or supporting all applicable DAS functional performance requirements.

This shall include point-by-point checks from the Control Centre to make sure that the database in the breaker's interface is properly mapped to the FRTU and DAS databases and making sure that the RMUs, SPBs and Sectionalizers after integrated with the DAS can meet the Employer's overall functional performance requirements.

The Supplier, therefore, shall support end-to-end testing which shall serve as a means of commissioning the by having adequate Contractor personnel on hand to witness these tests and to help resolve any RMUs, SPBs and Sectionalizers variances that may arise.

Variances specifically identified as RMUs, SPBs and Sectionalizers problems shall be taken care of as quickly as possible. Otherwise, commissioning of the RMUs, SPBs and Sectionalizers and the beginning of the corresponding warranty period may be unduly delayed.

Prior to starting the warranty period, the Contractor shall submit a report clearly identifying the results of all end-to-end tests from the perspective of the RMUs, SPBs and Sectionalizers. This shall include a summary of the variances detected and whether or not these variances were successfully corrected. Where necessary, for Employer consideration, the report shall include the Contractor's plan for resolving any and all variances not yet corrected.

No RMUs, SPBs and Sectionalizers installation shall be accepted as complete until the Employer is satisfied that all variances associated with an individual site have been corrected and that the RMUs, SPBs and Sectionalizers is SCADA ready, i.e., can be considered fully integrated with the DAS.

6. Training

The Contractor shall provide training to Employer personnel to prepare them to assume full responsibility for coordination and supervision of the Contractor's field work as well as future RMUs, SPBs, LRC, LBS & RTU assists in DAS Equipment maintenance activities. The training shall cover details concerning the coordination and setting of protection relays and the adjustment of parameters. To the fullest extent possible, training shall allow for hands-on implementation of the lessons learned during the training program.

All training shall be conducted in English using RMUs, SPBs and DAS Equipment including Protective relays, other components and its related maintenance tools and Relay Testing Equipments delivered by the Contractor.

The Employer shall be permitted to make video recordings of all training classes on the understanding that the Employer will use these for internal instruction purposes only.

There are three formal approaches to training, which as a minimum, shall be embodied into the contract deliverable:

1. Employer training for DAS equipments at OEM facility as follows: This phase provides deep technical knowledge and hands-on experience at the equipment manufacturer's facility.
 - a) 13 batches each comprising of 8 participants for a duration of 5 days for SPB, RMUs & RTU.
 - b) 3 batches each comprising of 5 participants for a duration of 10 days for LRC & LBS.
2. Specialized training (Classroom & Field) for LRC, LBS, SPB, RMUs & RTU at Project area in 4 batches each comprising of 10 participants for a duration of 10 days for Engineers, Switchgear

Operators, Maintenance Technicians, Safety Officers, Supervisors, Testing and commissioning team. Focused on the installation and commissioning of the 11kV system Site safety induction, equipment rigging, cable termination, protection relay testing, and system energization protocols.

3. Employer training (Classroom & Field) for LRC, LBS, SPB, RMUs & RTU at Project area in 25 batches each comprising of 25 participants for a duration of 2 days. Broad operational training for the wider workforce which includes DAS equipment operation, block diagrams, data flows, and diagnostic error messages and Use of the DAC Simulator, tool sets, and interface testing with the DAS master station.

6.1 Regulatory Framework and Compliance Requirements

The training program and associated infrastructure must align with the following statutory and technical standards to ensure full legal compliance and operational safety:

- The Electricity Act, 2003: Statutory compliance for electrical safety and operations.
- Electricity Rules, 1956/2005: Safety requirements for electrical installations.
- IS 13118 (Latest): Standards for metal-enclosed switchgear for rated voltages above 1 kV and up to 52 kV.
- IS 3427 (Latest): Standards for AC metal-enclosed switchgear and control gear.
- IS 9920 (Parts 1 to 4): Specifications for high-voltage switches.
- IS 9921 (Parts 1 to 5): Specifications for AC disconnectors and earthing switches.
- IS 12063: Classification of degrees of protection.
- IEC 62271-100/200: International standards for high-voltage switchgear and control gear.
- IEC 60298: International standards for AC metal-enclosed switchgear for rated voltages above 1 kV.
- IEC 60694 / 62271-1: Common clauses for MV switchgear standards and high-voltage switchgear/control gear.
- ANSI/IEEE C37.60-2003: Requirements for automatic circuit reclosers.
- CEA (Technical Standards) Regulations, 2010: Safety requirements for construction, operation, and maintenance.
- Factories Act, 1948 & OSH Code, 2020: Requirements for occupational safety and health.
- National Electrical Code of India: Standards for electrical installation safety.
- Cyber Security.

6.2 Training Infrastructure and Resource Requirements

To ensure the training program is executed effectively, the Contractor shall provide the following infrastructure and resources where applicable, at the manufacturing facility and the training venue in the project area shall be finalized only upon approval by the Employer

6.2.1 Physical Learning Infrastructure Facilities

- Training Classroom: An air-conditioned room capable of accommodating 25 participants, equipped with comfortable seating, adequate lighting, and ventilation.

- Audiovisual Aids: A fully functional setup including a projector, screen, and whiteboard to support instructional delivery.
- Computer Lab: Workstations equipped with simulation software, SCADA training modules, e-learning platforms, and documentation tools.
- Library & Reference Materials: Access to technical standards (IS, IEC), manufacturer manuals, equipment drawings, safety handbooks, reference books, and training videos.

6.2.2 Practical & Technical Infrastructure

- Practical Training Workshop: An indoor workshop featuring a de-energized 11kV switchgear training panel, RMU, SPB & RTU demonstration unit, and LRC & LBS mockups with adequate working space.
- Live Demonstration Facility: Supervised access to an operational 11kV substation or RMU, SPB, LRC & LBS installation for hands-on on-site training under strict safety protocols.
- Testing Equipment Laboratory: Provision of insulation resistance testers, contact resistance meters, relay test kits, timing test equipment, thermal imaging cameras, and multimeters.

6.2.3 Safety & Medical Resources

- Safety Equipment Store: A complete stock of PPE, including insulated gloves, safety helmets, arc flash suits, safety shoes, face shields, earthing equipment, and LOTO devices.
- First Aid Facility: A dedicated first aid room equipped with emergency medical supplies and a trained first-aider on standby during all sessions.

6.2.4 Instructor Qualification Requirements

Instructors need to be approved by the Employer, so their resumes shall be submitted at least one (1) month prior to conducting their assigned courses. In this respect, course instructors shall have demonstrated technical competence in the subject matter as well as previous instructing experience.

The Employer prefers instructors who specialize in course presentations. The Contractor may use the developers of the LRC, LBS, SPB, RMUs & RTU, in which case these developers shall use the Contractor's training staff as resources when preparing training courses and materials.

Where practical, subcontractors shall deliver training on their products directly in project area. The Contractor, however, shall remain responsible for selecting these courses, coordinating their delivery, and ensuring that all training objectives are met.

6.3 Training Curriculum

The training curriculum presented in this clause is intended to describe the contents of the training when viewed as a whole. The subjects covered by individual courses may differ as long as the overall objectives are satisfied.

The courses shall focus on the need for Employer personnel to fully understand the theoretical and practical details that relate to the functional design, configuration, installation, startup, testing, and maintenance of all components comprising the Contractor's LRC, LBS, SPB, RMUs & RTU. As a minimum, therefore, training shall include:

6.3.1 Employer training for LRC, LBS, SPB, RMUs & RTU at manufacturing facility

This training phase focuses on deep technical knowledge, equipment internals, and comprehensive overhaul procedures at the original equipment manufacturer (OEM) facility.

6.3.1.1 Technical Design and Theory:

- Equipment Internal Architecture: Detailed study of the internal components and construction of RMUs, SPBs, LRCs, and LBS.
- Advanced Protection Theory: In-depth training on protection relay logic, coordination, and advanced setting parameters.
- Control Logic and RTU Integration: Understanding the communication protocols and logic mapping between field equipment and the RTU.
- Manufacturing Quality Standards: Overview of the production standards and quality control measures applied during equipment assembly.

6.3.1.2 Practical Maintenance and Overhaul:

- Hands-on Assembly and Disassembly: Practical sessions involving the breakdown and reassembly of primary equipment modules.
- Component-Level Repair: Training on identifying and replacing printed circuit boards (PCBs), modules, and sub-assemblies.
- SF₆ Gas Management: Practical training on SF₆ gas filling, monitoring, and safe handling procedures.
- Diagnostic Testing: Mastery of diagnostic tools, including insulation resistance, contact resistance, and timing test equipment.

6.3.1.3 Advanced Testing and Troubleshooting:

- Relay Programming and Logic Testing: Use of advanced relay test kits to verify complex protection schemes.
- Factory Routine Tests: Participation in and understanding of the standard factory tests performed on new equipment.
- Advanced Troubleshooting: Systematic fault identification and resolution using manufacturer-specific diagnostic software and tools.
- Test Set Operation: Comprehensive training on the operation, maintenance, and repair of the Contractor's specialized test sets.

6.3.2 Training for Specialized training (Classroom & Field) for LRC, LBS, SPB, RMUs & RTU at Project area

6.3.2.1 Site Safety Induction Training

All personnel including contractors accessing project sites must complete mandatory site safety induction before site entry:

- Project-specific hazards and safety protocols
- Site access procedures and restricted zones
- Emergency procedures and assembly points
- PPE requirements for different work zones
- Incident reporting and communication protocols
- Environmental and housekeeping standards

6.3.2.2 Installation and Commissioning Training

Specialized training for installation teams and commissioning engineers:

Installation Training (RMU/LRC/LBS/SPB):

- Equipment handling, rigging, and transportation procedures
- Foundation preparation and equipment placement
- Mechanical assembly and alignment procedures
- Cable termination techniques (11kV cables)
- Earthing system installation and testing
- Control and auxiliary wiring
- Installation quality inspection checklists

Commissioning Training:

- Pre-commissioning safety procedures
- Visual and mechanical inspection protocols
- Insulation resistance and high voltage testing
- Protection relay testing and settings verification including specialized training on the Relay Testing Equipments for 11kV RMU System mentioned below.
- Performance validation and acceptance testing
- Documentation and handover procedures

The contractor shall provide six (6) complete sets of Relay Testing Equipments for 11kV RMU System: “3-Phase Current Injection Test Kit (Secondary Injection), Primary Current Injection Test Kit, Relay Test Set - Advanced(3phase), Insulation Resistance Tester (5kV), Digital Multimeter (True RMS), Earth Resistance Tester (3-Terminal), CT/PT Analyzer, High Voltage Test Kit (up to 28kV), Power Quality Analyzer, Circuit Breaker Timer, Contact Resistance Tester, Phase Sequence Indicator, Clamp Meter (1000A AC/DC), Digital Storage Oscilloscope (100MHz), Burden Test Kit, Laptop with Testing Software, Test Lead Set (Heavy Duty), Safety Equipment Kit 11kV rated(Gloves,

Insulating mats, Safety cones, Warning signs, First aid kit, Arc flash PPE), Calibration Standards & Accessories. System energization procedures and phasing checks as per the contract.

The contractor is required to provide fourteen (14) numbers of high-performance laptop units, identically configured with the latest licensed Windows Pro Operating System and hardware features, dedicated to the Project Management Office (PMO) for high-volume documentation, multimedia course review, real-time project scheduling, and formal approval workflows. These fourteen 14 number of units and the six (6) numbers of laptops with Relay testing Software mentioned above, must be strictly hardened for secure project implementation and field testing by disabling non-essential services, guest accounts, and unused communication ports, while specifically disabling "Auto-run" for all removable media to prevent malware transmission. To ensure data integrity and cybersecurity during commissioning, each laptop must be equipped with licensed antivirus software capable of offline updates and managed through a "Least Privilege" access model; field technicians shall utilize "Standard User" accounts for daily operations, restricting administrative privileges—protected by strong passwords or biometric authentication—solely for critical configuration changes and software installations.

6.3.3 Employer training (Classroom & Field) for LRC, LBS, SPB, RMUs & RTU at Project area

6.3.3.1 Class Room Training:

- Purpose of DAS Equipment from the perspective of supporting the Employer's overall functional requirements
- Theory of DAS Equipments operation including the RTU and, in the case of line reclosers, the auto-reclose and protection relay features
- Block diagrams and data flows describing the interrelationships between all components of the DAS Equipments
- Theory of operation of the Contractor's test sets and, to the extent practical, troubleshooting and repair of the test sets
- Orientation and coordination of the DAS Equipment and test set documentation such as manuals, configuration and assembly drawings, schematic diagrams, and part lists
- Safety procedures related to installing and maintaining the DAS Equipment.
- All diagnostic capabilities, including error messages and other indications, supported by the DAS Equipments.

6.3.3.2 Practical Training:

- Use of tools, relay test sets, and associated test equipment such as the DAC Simulator.
- Configuration, installation, startup, adjustment, and maintenance of the DAS Equipments and test sets
- Testing of DAS Equipment interfaces with the test set and DAS master station
- Diagnostics and verification of proper DAS Equipment and test set operations.

6.4 Training Documents

The Contractor shall prepare a training plan in cooperation with the Employer. The Contractor shall also be responsible for the preparation and production of all course material. Training documents shall be subject to Employer review and approval.

6.4.1 Training Plan and Schedule

The training plan shall support the schedule for manufacturing and installing the RMUs, SPBs and sectionalizer. A logical sequence of courses shall be arranged to include theoretical and practical concepts. The training program shall take into account the knowledge required by members of the Employer's project team to participate in a full and effective way in the project's RMUs, SPBs and sectionalizer activities.

The training plan shall list each course to be taken, a summary course description, and the dates for the course. The plan shall also reference the course description documents described below.

The schedule for all formal training courses shall be included in the project's detailed implementation schedule that the Contractor shall submit for review and approval by the Employer within 60 days before first training batch

6.4.2 Course Descriptions

Course descriptions shall be included with the training plan to provide the following information for each course included in the training plan same shall be submitted within 45 days before respective course commencement:

- Course name (and number if applicable)
- Brief description of course
- Brief description of intended audience for the course
- Description of the relationship of the course to other courses in the training plan
- Breakdown of course schedule including course duration and location and whether course is based on classroom or hands-on instruction.
- List of training materials and equipment to be supplied
- List of reference material to be used in each course
- List of any prerequisite training or experience expected of the attendees.

6.4.3 Course Materials

The Contractor shall provide all necessary training materials. Training materials such as class notes, overhead slides, and handouts shall be provided in English. Each trainee shall receive individual copies of these materials along with any reference materials such as Contractor or OEM technical manuals submitted as part of the RMUs, SPBs, RTUs and sectionalizer(LRC & LBS) documents.

All relevant course materials shall be submitted for Employer approval at least one month prior to each course. Subsequently, the approved course materials shall be transmitted to the attendees at least two weeks prior to the course.

Each trainee shall receive individual copies of the training materials and one additional set shall be provided for the Employer's archives. Class materials, including documents sent before the training classes and class handouts, shall become the property of the Employer. As such, the Contractor shall permit unrestricted reproduction of the material by the Employer (for internal use).

Assessment Materials- Question banks, practical evaluation checklists, assessment forms, answer keys, grading rubrics, Assessment Results: Within 7 days after completion of each batch

Training Records-Attendance registers, assessment results, certificates issued, participant feedback forms, training effectiveness reports and Training Completion Report: Within 30 days after completion of all training

6.5 Contractor Responsibilities (training)

The Contractor shall be responsible for the following aspects of training delivery:

1. Prepare comprehensive Training Plan and Schedule in coordination with Employer
2. Develop all training materials including course content, presentations, handouts, and assessment materials
3. Arrange qualified trainers meeting the specified qualification requirements
4. Provide all necessary training equipment, tools, demonstration units, and safety equipment
5. Arrange training facilities including classrooms, workshops, and demonstration areas at manufacturer facility and Project Area
6. Bear all costs for participant travel including air transportation, local conveyance, accommodation, and meals along with associated living expenses during manufacturer facility training.
7. If OEM based in foreign country, the Contractor shall meet all the expenses of the participants such as TO and FRO travel from the Employer's site to the training facility, boarding & lodging facilities, local transportation, medical expenses (insurance), daily maintenance and living expenses & all such other expenses required for the participants for the entire duration of the training period. Medical Insurance notwithstanding all support shall be extended to the participants during medical exigencies if any. In addition, in the event of the Contractor's training outside of the country, the per diem allowance as per the prevailing Government norms shall be paid to the participants. Support for the Employer in preparing and submitting the proper governmental forms for the participants to gain entrance into the country, if applicable, where the Contractor's facility is located.

8. Perform assessments and issue certificates to successful participants
9. Maintain comprehensive training records and provide reports to Employer
10. Provide remedial training for participants who do not meet pass criteria
11. Coordinate training schedules with project implementation to minimize operational disruption
12. Supply operation and maintenance manuals, technical documentation, and spare parts catalogues

6.6 Employer Responsibilities(Training):

The Employer (BESCOM) shall be responsible for the following:

1. Nominate appropriate personnel for training based on job roles and requirements
2. Review and approve training plan, schedule, course content, and materials
3. Training documents shall be subject to the review and approval process during the Design stage of the Project.

6.7 Training Budget

The Employer expects that the courses to be taken and the number of students attending each course will change over the course of this Contract. Therefore, the total cost of all training included in this Contract shall be considered as an allocation, and the Employer shall inform the Contractor and revise the training curriculum and the attendants at each course as long as the training allocation is not exceeded. The Contractor shall update the training budget each month with the actual costs of the courses taken by the Employer throughout the duration of the project via the periodic progress reports. In addition, the Contractor shall provide the per student cost and the sliding scale to attend training at the Contractor's facility, and the per course cost to perform the training at the Employer's site

6.7.1 No Additional Charges

Payment for the training and inspection will be the responsibility of the Employer. However, the Contractor shall be responsible for the cost of additional courses and the travel and living expenses of employer attending the courses where the need for such additional training is attributed to any of the following conditions:

1. Delays in the project schedule caused by the Contractor.
2. Inadequate or poor quality training that fails to meet the Employer's requirements for quality, content, or timeliness.

Any change in the scope of this Contract, unless the cost of the additional training is included in the cost of the change

7. Documentation

It is the intent of the Employer to become self sufficient in all aspects of the RMUs, SPBs, RTUs and Sectionalizers(LRC & LBS). In order to assure that the Employer has the opportunity to become self sufficient in a timely and orderly manner, it is necessary that the Contractor provide high quality documentation.



As a minimum, in addition to typical project documentation such as transmittal, meeting minutes, and progress reports, the documentation shall include manuals, drawings, and data covering functional design, configuration, testing, installation, startup, operation, and maintenance details for the RMUs, SPBs, RTUs and Sectionalizers(LRC & LBS) and their associated equipment.

The documentation shall reflect the actual equipment and its hardware and software configurations as supplied. This shall include the functionality, performance, and operation of the RMUs, SPBs, RTUs and Sectionalizers(LRC & LBS) in their final operationally acceptable form.

The Employer shall be permitted to copy all documents or drawings for internal use. All documentation shall be in English. One set of manual, drawing, and data documents shall be shipped with each delivered RMUs, SPBs, RTUs and sectionalizers(LRC & LBS). Two additional sets corresponding to each type of RMUs, SPBs, RTUs and sectionalizers(LRC & LBS), shall be provided for archiving at Employer headquarters.

7.1 Document Review and Approval

All standard and OEM documents provided in accordance with this contract shall be subject to review by the Employer. Custom documents shall be subject to review and approval by the Employer.

The acceptance or approval of any documents by the Employer shall not relieve the Contractor of the responsibility to meet all of the requirements of the contract including responsibility for correction of the documents.

The Contractor shall have no claim for additional costs or extensions of time on account of delays due to document revisions that may be necessary to ensure compliance with the contract.

All deliverable documentation shall be revised by the Contractor to reflect the delivered RMUs, SPBs, RTUs and Sectionalizers(LRC & LBS). Any modifications resulting from factory and site acceptance tests shall be incorporated.

All previously submitted documents that have been changed because of subsequent engineering changes, contract changes, or errors or omissions shall be resubmitted for review or approval as appropriate.

7.2 Hardware Documentation

As a minimum, the following documentation shall be provided for all hardware provided pursuant to this contract:

- List of deliverable hardware
- Configuration diagrams
- Site installation drawings and procedures

- Equipment manuals
- Hardware maintenance manuals

The equipment and hardware maintenance manuals to be supplied shall be commensurate with the hardware maintenance philosophy to be used by the Employer, which is to maintain all hardware after acceptance using its own staff to the fullest extent possible.

7.2.1 List of Deliverable Hardware

The list of deliverable hardware shall itemize each hardware component along with associated accessories such as cables and connectors. It shall also include equipment configuration information of sufficient detail that the Employer can procure an identical hardware item from the manufacturer.

7.2.2 Configuration Diagrams

The configuration diagrams shall depict in detail the specific equipment comprising the RMUs, SPBs, RTUs and Sectionalizers(LRC & LBS), including all items such as switches, protection relay, local control panel, RTU, and switch power supply, and the logical and physical interconnection of this equipment operating as an integrated system.

The configuration diagrams shall also show how the RMUs, SPBs, RTUs and sectionalizers(LRC & LBS) interconnect with the equipment to be supplied by the Employer or other contractors. This shall include, for example, connections related to the distribution network and RTU.

Each interconnecting cable to be provided by the Contractor shall be identified along with its terminations. All equipment and cabling shall be identified using the same terminology as the list of deliverable hardware so that the correspondence between this list and the configuration diagrams can be readily determined.

7.2.3 Site Installation Drawings

The site drawings shall depict the physical arrangement of the RMUs, SPBs, RTUs and sectionalizers(LRC & LBS) components. References to the appropriate equipment manuals are acceptable. The drawings and procedures shall include:

- Equipment physical drawings showing dimensions, cabinet internal arrangements, and the size and weight of each enclosure
- Unpacking, moving, handling, and other installation details
- The location of external connections including types and sizes of connectors
- Input power and grounding requirements
- Environmental requirements (if any).

7.2.4 Equipment Manuals

Equipment manuals shall contain the following:

- Description of the function of the equipment
- Installation, setup, and operating instructions
- Block diagram showing logical and physical interconnections among major components
- Expansion and upgrade capabilities and instructions
- Preventive maintenance instructions
- Detailed functional, logical, electrical, and mechanical characteristics of all equipment including protocol descriptions
- Troubleshooting and repair guides, including descriptions and instructions for the diagnostics furnished.

7.3 Operating Manuals

The Contractor shall submit, for review and approval, operating manuals for all RMUs, SPBs, RTUs and Sectionalizers(LRC & LBS) components. These manuals shall be in English. They shall include the RMUs, SPBs, RTUs and Sectionalizers(LRC & LBS) operating instructions. Context sensitivity shall be used to go directly to the appropriate place in the manual.

The manuals shall be organized for quick access to each detailed description of the operator procedures that are required to interact with the RMUs, SPBs, RTUs and Sectionalizers(LRC & LBS) functions. This shall include the procedures to define, build, edit, and expand all data points provided with the RMUs, SPBs, RTUs and Sectionalizers(LRC & LBS).

The manuals shall present in a clear and concise manner all information that operators, including maintenance personnel, need to know to understand and operate RMUs, SPBs, RTUs and Sectionalizers(LRC & LBS) satisfactorily. The manuals shall make abundant use of diagrams and/or photographs to illustrate the various procedures involved.

7.4 As-Built Documents and Drawings

The Contractor shall submit as-built documents including applicable drawings for review and approval. All deliverable documents and drawings shall be revised by the Contractor to reflect the as-built RMUs, SPBs, RTUs and Sectionalizers(LRC & LBS) components including all the Relay, and MFM devices. Any errors in or modifications to a RMUs, SPBs, RTUs and Sectionalizers(LRC & LBS) resulting from its factory and/or site acceptance test shall be incorporated. Within this same context, all previously submitted documents that are changed because of engineering changes, contract changes, errors, or omissions shall be resubmitted for review and approval.